

We claim:

1. A hard capsule comprising

(A) polymers obtainable by free-radical polymerization of

a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of

b) polyether-containing compounds and

c) where appropriate one or more other copolymerizable monomers c) and subsequent at least partial hydrolysis of the ester functions in the original monomers a),

with the proviso that in the absence of another copolymerizable monomer c) the polyether-containing compound b) must have a number average molecular weight ≤ 10,000,

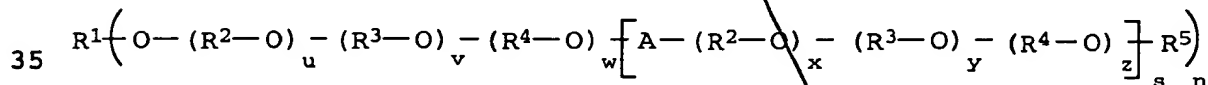
(B) where appropriate structure-improving auxiliaries and

(C) other conventional constituents.

2. A hard capsule as claimed in claim 1, wherein the polymers (A) are obtainable by free-radical polymerization of

a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of

b) polyether-containing compounds of the general formula I



in which the variables have, independently of one another, the following meaning:

R<sup>1</sup> hydrogen, C<sub>1</sub>-C<sub>24</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-, polyalcohol residue;

R<sup>5</sup> hydrogen, C<sub>1</sub>-C<sub>24</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

R<sup>2</sup> to R<sup>4</sup>

34

$-(CH_2)_2-$ ,  $-(CH_2)_3-$ ,  $-(CH_2)_4-$ ,  $-CH_2-CH(R^6)-$ ,  
 $-CH_2-CHOR^7-CH_2-$ ;

$R^6$   $C_1-C_{24}$ -alkyl;

$R^7$  hydrogen,  $C_1-C_{24}$ -alkyl,  $R^6-C(=O)-$ ,  $R^6-NH-C(=O)-$ ;

A  $-C(=O)-O$ ,  $-C(=O)-B-C(=O)-O$ ,  
 $-C(=O)-NH-B-NH-C(=O)-O$ ;

B  $-(CH_2)_t-$ , arylene, optionally substituted;

n 1 to 1000 (1-200);

s 0 to 1000 (0-200);

t 1 to 12 (1-12);

u 1 to 5000 (1-250);

v 0 to 5000 (0-250);

w 0 to 5000 (0-250);

x 0 to 5000 (0-250);

y 0 to 5000 (0-250);

z 0 to 5000 (0-250);

and

c) where appropriate one or more other copolymerizable monomers

and subsequent at least partial hydrolysis of the ester functions in the original monomers a), with the proviso that b) in the absence of c) has a number average molecular weight between 300 and 10,000, and n-z have the values stated in parentheses.

3. A hard capsule as claimed in either of claims 1 or 2, wherein the polymers (A) are obtainable by free-radical polymerization of

45

35

a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of

b) polyether-containing compounds of the general formula I with a number average molecular weight of from 300 to 100,000, in which the variables have, independently of one another, the following meaning:

R<sup>1</sup> hydrogen, C<sub>1</sub>-C<sub>12</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-, polyalcohol residue;

R<sup>5</sup> hydrogen, C<sub>1</sub>-C<sub>12</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

R<sup>2</sup> to R<sup>4</sup>

-(CH<sub>2</sub>)<sub>2</sub>-, -(CH<sub>2</sub>)<sub>3</sub>-, -(CH<sub>2</sub>)<sub>4</sub>-, -CH<sub>2</sub>-CH(R<sup>6</sup>)-,  
-CH<sub>2</sub>-CHOR<sup>7</sup>-CH<sub>2</sub>-;

R<sup>6</sup> C<sub>1</sub>-C<sub>12</sub>-alkyl;

R<sup>7</sup> hydrogen, C<sub>1</sub>-C<sub>12</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

n 1 to 8;

s 0;

u 2 to 2000 (2-250);

v 0 to 2000 (0-250);

w 0 to 2000 (0-250);

and

c) where appropriate one or more other copolymerizable monomers

and subsequent at least partial hydrolysis of the ester functions in the original monomers a), with the proviso that b) in the absence of c) has a number average molecular weight between 300 and 10,000, and u-w have the values stated in parentheses.

4. A hard capsule as claimed in any of claims 1 to 3, wherein the polymers (A) are obtainable by free-radical polymerization of

36

a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of

b) polyether-containing compounds of the general formula I with a number average molecular weight of from 500 to 50,000, in which the variables have, independently of one another, the following meaning:

R<sup>1</sup> hydrogen, C<sub>1</sub>-C<sub>6</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

R<sup>5</sup> hydrogen, C<sub>1</sub>-C<sub>6</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

R<sup>2</sup> to R<sup>4</sup>

-(CH<sub>2</sub>)<sub>2</sub>-, -(CH<sub>2</sub>)<sub>3</sub>-, -(CH<sub>2</sub>)<sub>4</sub>-, -CH<sub>2</sub>-CH(R<sup>6</sup>)-,  
-CH<sub>2</sub>-CHOR<sup>7</sup>-CH<sub>2</sub>-;

R<sup>6</sup> C<sub>1</sub>-C<sub>6</sub>-alkyl;

R<sup>7</sup> hydrogen, C<sub>1</sub>-C<sub>6</sub>-alkyl, R<sup>6</sup>-C(=O)-, R<sup>6</sup>-NH-C(=O)-;

n 1;

s 0;

u 5 to 1000 (5-250);

v 0 to 1000 (0-250);

w 0 to 1000 (0-250);

and

c) where appropriate one or more other copolymerizable monomers

and subsequent at least partial hydrolysis of the ester functions in the original monomers a), with the proviso that b) in the absence of c) has a number average molecular weight between 300 and 10,000, and u-w have the values stated in parentheses.

5. A hard capsule as claimed in any of claims 1 to 4, wherein the polymers (A) are obtainable by free-radical polymerization of

- a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of
- b) polyether-containing compounds and
- c) where appropriate 0 to 20% by weight of one or more other copolymerizable monomers

and subsequent at least partial hydrolysis of the ester functions in the original monomers a), wherein the polyether-containing compounds b) have been prepared by polymerization of ethylenically unsaturated alkylene oxide-containing monomers, and, where appropriate, other copolymerizable monomers.

6. A hard capsule as claimed in any of claims 1 to 5, wherein if at least one other copolymerizable monomer c) is present it is selected from the group:

acrylic acid, methacrylic acid, maleic acid, fumaric acid, crotonic acid, maleic anhydride and its monoesters, methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, n-butyl acrylate, n-butyl methacrylate, t-butyl acrylate, t-butyl methacrylate, isobutyl acrylate, isobutyl methacrylate, 2-ethylhexyl acrylate, stearyl acrylate, stearyl methacrylate, N-t-butylacrylamide, N-octylacrylamide, 2-hydroxyethyl acrylate, hydroxypropyl acrylates, 2-hydroxyethyl methacrylate, hydroxypropyl methacrylates, alkylene glycol (meth)acrylates, styrene, unsaturated sulfonic acids such as, for example,

- 30 acrylamidopropanesulfonic acid, vinylpyrrolidone,  
vinylcaprolactam, vinyl ethers (for example: methyl, ethyl,  
butyl or dodecyl vinyl ether), vinylformamide,  
vinylmethacetamide, vinylamine, 1-vinylimidazole,  
1-vinyl-2-methylimidazole, N,N-dimethylaminomethyl  
35 methacrylate and N-[3-(dimethylamino)propyl]methacrylamide;  
3-methyl-1-vinylimidazolium chloride,  
3-methyl-1-vinylimidazolium methyl sulfate,  
N,N-dimethylaminoethyl methacrylate,  
N-[3-(dimethylamino)propyl]methacrylamide quaternized with  
40 methyl chloride, methyl sulfate or diethyl sulfate.

7. A hard capsule as claimed in any of claims 1 to 6, wherein the ratios of amounts are

- a) 10 to 98% by weight  
b) 2 to 90% by weight

c) 0 to 50% by weight.

8. A hard capsule as claimed in any of claims 1 to 7, wherein the ratios of amounts are

5

a) 50 to 97% by weight

b) 3 to 50% by weight

c) 0 to 20% by weight.

10 9. A hard capsule as claimed in any of claims 1 to 8, wherein the ratios of amounts are

a) 65 to 97% by weight

b) 3 to 35% by weight

15 c) 0 to 20% by weight.

10. A hard capsule as claimed in any of claims 1 to 9, wherein the resulting polymers are subsequently crosslinked by a polymer-analogous reaction.

20

11. A hard capsule as claimed in any of claims 1 to 10, wherein dialdehydes, diketones, dicarboxylic acids, boric acid, boric acid salts, and salts of multiply charged cations are employed for the subsequent crosslinking.

25

12. A hard capsule as claimed in any of claims 1 to 11, wherein the structure-improving auxiliaries (B) employed are the following classes of compounds:

30 a) polymers with a molecular weight greater than 50,000

b) substances which lead to crosslinking of the polymer chains of the polymers,

35 c) and, where appropriate, substances which lead to crosslinking of the polymer chains of the structure-improving auxiliaries.

40 13. A hard capsule as claimed in any of claims 1-12, wherein the structure-improving auxiliaries employed are polymers from the following classes of substances:

45 polyamino acids such as gelatin, zein, soybean protein and derivatives thereof, polysaccharides such as starch, degraded starch, maltodextrins, carboxymethylstarch, cellulose, hydroxypropylmethylcellulose, hydroxypropylcellulose, hydroxyethylcellulose, methylcellulose,

Sup  
AI  
Cmt

RECEIVED  
FEB 11 1960

- carboxymethylcellulose, ethylcellulose, cellulose acetate, cellulose acetate phthalate, hydroxypropylcellulose acetate phthalate, hydroxypropylcellulose acetate succinate, hemicellulose, galactomannans, pectins, alginates,
- 5 carrageenans, xanthan, gellan, dextran, curdlan, pullulan, gum arabic, chitin, and derivatives thereof, synthetic polymers such as polyacrylic acid, polymethacrylic acid, copolymers of acrylic esters and methacrylic esters, polyvinyl alcohols, polyvinyl acetate, polyethylene glycols,
- 10 polyoxyethylene/polyoxypropylene block copolymers, polyvinylpyrrolidones and derivatives thereof.
14. A hard capsule as claimed in any of claims 1 to 13, which comprises as other conventional shell constituents fillers,
- 15 release agents, flow aids, dyes, pigments, opacifiers, flavorings, sweeteners, plasticizers, preservatives and/or active ingredients.
15. A hard capsule as claimed in any of claims 1 to 14, wherein
- 20 the shell consists of 10 to 100% polymers of vinyl esters on polyether, where appropriate 0 to 80% structure-improving auxiliaries and, where appropriate, 0 to 30% other conventional constituents.
- 25 16. A hard capsule according to any of claims 1 to 15, obtainable by the dip process.
17. A hard capsule as claimed in any of claims 1 to 16, which comprises one or more active pharmaceutical ingredients,
- 30 vitamins, carotenoids, minerals, trace elements, food supplements, cosmetic active ingredients, crop protection agents, bath additives, perfume, flavoring, cleaner or detergent.
- 35 18. A hard capsule as claimed in any of claims 1 to 17, wherein the shell comprises from 20 to 80% of a polymer resistant to gastric fluid.
19. A hard capsule as claimed in any of claims 1 to 18, wherein a
- 40 coating resistant to gastric fluid is applied using pharmaceutically customary coating processes to achieve resistance to gastric fluid after production.
20. The use of the hard capsule as claimed in any of claims 1 to
- 45 19 for pharmaceutical applications.

Sub  
B1  
cont

RECEIVED  
F. B. 2300

40

21. The use of the hard capsule as claimed in any of claims 1 to 19 for cosmetic applications, applications in crop protection, or for cleaners or food supplements.

5 22. The use of polymers obtainable by free-radical polymerization of

a) at least one vinyl ester of C<sub>1</sub>-C<sub>24</sub>-carboxylic acids in the presence of

10

b) polyether-containing compounds and

c) where appropriate one or more copolymerizable monomers

15

and subsequent at least partial hydrolysis of the ester functions in the original monomers a), with the proviso that b) in the absence of c) has a number average molecular weight between 300 and 10,000 for producing a hard capsule as claimed in any of claims 1 to 19.

20

25

30

35

40

45

P. 0050/51280

Zus  
A1  
Cont